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Long-Term Growth of the U.S. Economy: Significance, Determinants, and Policy

Updated May 25, 2006

Congressional Research Service
https://crsreports.congress.gov
RL32987

CRS REPORT
Prepared for Members and
Committees of Congress

Summary

The rate of long-term economic growth is the salient measure of the nation's ability to steadily advance its material living standard. The pace of long-term economic growth is likely to be a center of attention in the decades just ahead, as the U.S. economy confronts the need to undertake unprecedentedly large generational transfers of income to pay for the retirement of the huge baby-boom generation as well as large transfers to the rest of the world to meet the debt service costs of the United States' large and still growing foreign debt.

For the United States, the long-term growth of real GDP *per-capita* over the last 125 years has revealed remarkable steadiness, advancing decade after decade with only modest and temporary variation from a trend annual average rate of growth of 1.8%. Overall, the limited variability of the rate of U.S. long-term growth, despite major changes in economic conditions, as well as economic and social policies, suggests that U.S. long-term growth may be governed by forces other than typical economic variables and may not be easy to alter with conventional economic policy. Nevertheless, the evidence of some degree of medium-term variability suggests the possibility of using economic policy to exert some influence. It is important to recognize that even relatively small differences in the rate of economic growth will steadily cumulate to have large effects on the scale of improvement in future living standards. Such an improvement would make the burden of future transfers on workers less onerous.

Given a supporting *social infrastructure* that encourages and enables production of goods and services, economic theory and evidence make it reasonably clear that countries that have achieved sustained long-term growth such as the United States are those that invest a sizable fraction of current income in the accumulation of *physical and human capital* and have and continue to accumulate large stocks of both. As importantly, they are also economies that have been able to steadily raise the productivity of these two inputs through a steady advance of *technical knowledge.* There are reasons to believe, despite its evident economic success, that the United States, due to varying degrees of market failure, may under invest in each of the three determinants of economic growth. In theory, correcting that under investment through some form of government intervention could lead to an optimal increase in the rate of accumulation of each determinant, and through that to an acceleration of the economy's rate of economic growth. Knowing that there is the potential for improving on certain market outcomes is one thing. Designing economic policies that will efficiently induce these improvements is another thing. The information shortcoming about what, where, and how much to invest with which the policymaker would have to contend will often be substantial, and greatly raises the risk that the policy will be so blunt and misdirected that it will generate more economic costs than benefits.

This report will be updated annually.

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Introduction

The rate of long-term economic growth is the salient measure of the nation's ability to steadily advance its material living standard. That living standard advances by increasing the economy's capacity to produce goods and services and thereby expanding the range of choices open to society. Today's level of gross domestic product (GDP) per person is 15 to 25 times that of a person alive in 1895. This degree of improvement in material well-being is not only the result of today's far lower cost *relative* to income of directly comparable products (such as an hour of illumination, a new suit of clothes, or a chair) but also the availability of an array of products that defines our current standard of living (such as a cd player, air conditioning, tv, and air travel) that were not available at any price in 1895.

Aside from the creation of new products, economic growth has also meant a dramatic change in *what* we do. Agriculture has gone from the principal occupation to that of a tiny share of the labor force. The automobile has transformed how we move about and where we live. Higher education has become an endeavor of the many rather than the few. Hours of work have decreased while hours of leisure have increased.

The pace of long-term economic growth is likely to be a central focus of attention in the decades just ahead, as the U.S. economy must confront the need to undertake unprecedentedly large generational transfers of income to pay for the retirement of the huge baby-boom generation. Faster economic growth leads to a larger economic pie from which to make such transfers and makes this redistribution less onerous for future workers.[1]

Another element of concern about the future burden on workers grows out of the United States' large accumulation of foreign debt stemming from a long succession of large trade deficits. With a net foreign debt that now approaching $3 trillion and could plausibly approach $10 trillion in the decade ahead, the United States could expect to have to make annual debt service payments to foreign creditors of $80 to $100 billion. This means that a significant share of future output growth will be transferred to foreigners and will not be available to improve the future living standard of domestic consumers. Again, the eroding effect of these transfers on future living standards of workers will be less if the annual rate of long-term growth is greater.[2]

Although the trend growth rates of mature industrial economies have historically not shown great variability, even relatively small differences in that growth rate steadily cumulate to have sizeable effects on the scale of improvement in future living standards. An economy in which output per capita grows at an average annual pace of 2.0% will double in size in 34 years, while growth at 3.0% leads to a doubling in size in only 24 years. Put another way, beginning at the 2004 level of real GDP per capita of about $37,000, at the end of 24 years a 3% annual growth rate generates a level of per capita real GDP of about $75,000, as compared to a level of only about $59,000 generated by a 2% annual growth rate for the same time interval. That extra $16,000 confers a substantial broadening of economic choices and the ability to achieve any given spectrum of economic and social goals with less sacrifice.

Despite its importance for future living standards, long-term growth is seldom the explicit interest of economic policy. Nevertheless, many policies directed at more immediate goals are likely to have implications for the speed of economic growth. Tax policy, labor market policy, science and technology policy, education policy, budget policy, as well as legal and regulatory policy can all have effects on the rate of economic growth and the level of future income. If a more explicit

[1] See CRS Report RL31498, *Social Security Reform: Economic Issues*, by Jane G. Gravelle and Marc Labonte.

[2] See CRS Report RL31032, *The U.S. Trade Deficit: Causes, Consequences, and Cures*, by Craig K. Elwell.

concern with the rate of long-term growth is thought appropriate by policy makers, then it will be important to understand: what the salient determinants of long-term growth are; whether the decisions of economic agents in private markets lead to a economically optimal allocation of resources to each determinate; how could economic policy most successfully correct for a particular market failure; and what admixture of particular economic policies are likely to offer the best chance of achieving an optimal rate of improvement in future living standards.

Definitions, Measurement, and Goals

There are some other distinctions about long-term growth that should be understood before proceeding. First, long-term growth refers to an economy increasing its productive capacity or what is usually called "potential output." This is somewhat distinct from short-run changes in economic activity over the course of the business cycle, such as recovery from recession. The short-term goal is to have the economy operate near potential output, while the long-term goal is to steadily increase potential output.

Short-term performance is certainly going to have an effect on long-term economic performance, but there will also be important differences in the forces governing each, as well as different policy implications presented by each. For example, in the short run in an economy operating below potential output due to slack demand, monetary and fiscal policy can stimulate aggregate demand, accelerate economic growth and push an economy towards potential output. But these policies may have little impact on the rate at which potential output expands. The distinct forces that govern the growth of potential output—or aggregate supply—are the concern of this report.

Second, analysis of long-term growth focuses on the growth of *per capita* output, most often measured as real (or inflation adjusted) GDP divided by the nation's population, as more GDP per capita will likely be the essential requirement for a higher standard of living. It is possible to increase real GDP per capita by increasing the percentage of the population in the labor force or the average hours worked by the labor force. But both of these actions are bounded in that you can only increase the labor force up to the size of the population (and realistically the upper bound will be well short of that) and increase the average hours of work up to 24 hours a day (and, again, realistically the upper bound will be well short of that). Therefore, these are not actions that can cause a sustained increase in the rate of long-term growth. This is probably particularly true for a mature economy such as the United States' where these labor force parameters tend to be relatively stable. More fundamentally, one can question whether increases in per-capita GDP by such means represents a true rise in the standard of living. As we will see, a focus on per-capita output points to a critical requirement for long-term growth and a rising standard of living—increased efficiency, or productivity, that is, doing things that enable each worker to steadily produce more in any given time period.

The standard measure of economic growth—increased real GDP/population—does not always function as a precise gauge of changes in economic welfare. Many valuable things are simply not measured in GDP. For example, leisure time, child rearing, and volunteer work all contribute to our well-being but they are not reflected in GDP. Therefore, if parents decided to work fewer hours to spend more time rearing their children, measured GDP would fall but general well-being could increase rather than fall.

Also, many negative things can occur with economic growth that subtract from our well-being but are not counted as decrements in measures of real GDP. Environmental damage, increased income inequality, decreased quality of public education, or falling public health decrease economic well-being, but do not necessarily result in a corresponding reduction of measured GDP.

Conversely, there are things measured in GDP, such as more prisons, more locks on doors, and expenditures to protect against terrorism, that do not easily correlate with a rising living standard. Nevertheless, while greater GDP does not assure a higher living standard, it provides the *potential* means for achieving greater well-being by making the various elements of how we choose to define that well-being more affordable. More affordable in economics is essentially a reduction in the number and degree of tradeoffs confronted in economic life. If we choose to work fewer hours or reduce environmental damage then we can do so with less sacrifice of other things if GDP is greater.[3]

Another important economic distinction between growth and economic welfare is that society's economic objective is not likely to be reaching the maximum rate of growth that is possible, but rather, achieving the *optimal* rate of growth. That economic policy has the ability to accelerate the rate of long-term growth does not necessarily mean that it should. Because faster future growth usually means that the economy must divert resources from the production of goods for current consumption and toward growth-generating activities, the growth rate consistent with an optimal balance between the level of current consumption and the raised level of future consumption will likely be far short of the greatest possible rate.

Super-fast growth would have little appeal if the fruits of that achievement are never consumed because they must be continuously diverted to the investment needed to sustain that growth rate. Private economic agents will make decisions in the market place that establish a relative valuation of current versus future output, but if there is some degree of market failure, this outcome will not be the optimal one and economic policy can potentially improve on the market outcome.

The Growth Record

Sustained economic growth, anywhere, is a relatively recent historical phenomenon. While our knowledge is imperfect, before 1500 there is no record of any increase in output per capita anywhere in the world for millennia. And only after 1800 is there consistent evidence of sizeable *sustained* increases in living standards across the globe. Between 1800 and 1900, output per capita in the industrializing economies probably grew on average at 1.0% per year. Between 1900 and 2000, that rate of growth likely accelerated to about 2.0%. This may seem to be a modest pace, but its was a sharp break from the stagnation and poverty that had prevailed for centuries before, and because it was a *sustained* rate of increase generating cumulative gains, it was sufficient to steadily advance standards of living at a historically unprecedented speed, and ultimately transform the world economy.[4]

We also observe over the last 100-year span that the rates of economic growth across the then emerging industrial nations were fairly tightly clustered around this 2.0% pace. At the high end was Japan with an annual rate of growth averaging about 2.7%, while at the low end was Great Britain with an annual growth rate averaging 1.4%. The United States, which grew at a 1.8% average annual rate, was slightly below average. In the 25 year subperiod of 1980-2004, this clustering has become tighter and the relative speed ranking has also changed. Among the major advanced industrial economies, the United Kingdom grew fastest at 2.3%, Japan's growth decelerated to 2.0%, U.S. growth accelerated to 2.0%, and the major European economies (Germany, France, Italy and, the Netherlands) grew relatively slower, with each achieving a 1.6%

[3] For more discussion on the task of measuring GDP see N. Gregory Mankiw, *Principles of Economics.* (Fort Worth TX: Dryden Press, 1997), pp. 477-494.

[4] J. Bradford DeLong, *Macroeconomics*, (New York: McGraw-Hill Companies, 2002), Chapter 5.

pace. In general, this convergence of growth paths among the industrial economies has meant that the differences in average growth rates of per-capita output are typically only a few tenths of a percentage point.[5] However, over the long-run, a few percentage points more will make a substantial difference in the cumulative gain in the nations' material standard of living.

For the United States, the long-term growth of real GDP per capita over the last 125 years has revealed remarkable steadiness, advancing decade after decade with only modest and temporary variation from the observed 1.8% annual rate of increase. This constancy is not absolute, however. There has been short-run variability caused by the business cycle, but on balance these short-run effects do not deflect the underlying long-term trend.

There has also been some medium-term variability, however, that demarcates some distinct subperiods for U.S. economic growth. Growth decelerated to a 1.4% pace in the 1929-1950 period, a slowdown primarily reflecting the large and pervasive crippling effects of the Great Depression on economic activity throughout the 1930s. From 1950 to 1973, economic growth accelerated to an above trend average annual pace of 2.1%, as the United States (and the world) experienced a strong economic rebound after WWII. The most pronounced deviation from the long-term trend occurred from 1973 to 1995, with the growth rate of per-capita GDP slowing to 0.6%. (Other industrial economies also experienced similar or larger decelerations of economic growth.) Unlike the period of the Great Depression this slowdown was not a matter of persistent slack demand, for the economy was most often operating at capacity.[6] Rather, the U.S. economy's productive capacity was just expanding at a much slower rate. While some slowing from the post-war boom could be expected, this degree of deceleration went well below the long-term trend and why it did so remains largely an economic mystery. Since 1995, the speed of U.S. economic growth accelerated once again, reaching a pace of 2.3%, somewhat above the trend rate for the complete post-World War II period. This above-average rate of growth is attributable to the economic boom of the late 1990s. Over the second half of this decade, growth was somewhat below the long-term trend, largely due to the effects of the 2001 recession.[7]

Overall, the limited variability of the rate of U.S. long-term growth over such a long time period, despite major changes in economic conditions, as well as economic and social polices, suggests that U.S. long-term growth may be governed by forces other than typical economic variables and may not be easy to deliberately alter with conventional economic policies.

Nevertheless, the evidence of some degree of medium-term variability suggests the possibility of using economic policy to exert some influence. The reasons for those medium-term decelerations and accelerations may reveal the do's and don'ts of accelerating economic growth. In the next section, the report examines the current economic understanding of the determinants of long-term economic growth and what the behavior of those determinants suggests to be possible channels by which economic policy might be able to accelerate economic growth.

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5 Angus Maddison, *Dynamic Forces in Capitalist Development: A Long-run Comparative Study*. (Oxford: Oxford University Press, 1991).

6 There were four recessions in this period, but the economy recovered from each and quickly returned to full capacity output.

7 DeLong, op. cit. For more discussion of the mid-1970s growth slowdown, the mid-1990s growth acceleration, and prospects for the future see CRS Report RL32456, *Productivity: Will the Faster Growth Rate Continue?*, by Brian W. Cashell.

The Determinants of Long-Term Growth

A rising living standard is the result of increasing the productive power of workers, causing over time an increase in the amount of goods and services the average worker can produce per hour, or what is most often called—*increased productivity.* Economists have isolated a series of factors, which through accumulation and interaction, are thought to play critical roles for generating steady increases in productivity and sustained long-term growth. Three factors: *physical capital, human capital, and technological knowledge* are seen playing a direct role in magnifying the worker's productivity.

Other factors of importance play a more indirect role. These include the laws, government policies, and institutions that come together to create a *growth infrastructure* that encourages, enables and co-ordinates the economic behavior that causes steady accumulation of physical capital, human capital, and technical knowledge, which, in turn, together generate sustained long-term growth.

Physical Capital

Equip a worker with better tools and her productive power rises. She will be able to dig more in an hour with a shovel than with a stick, and more still with a backhoe than a shovel. Such tools that leverage the productive power of the average worker the economist calls physical capital and the process of providing the average worker with more powerful tools is termed *capital deepening*. To accomplish capital deepening an economy must divert some resources from producing goods for current consumption to the production of capital goods such as factories, machine tools, computers, or transportation equipment. In themselves capital goods do nothing to satisfy current wants and needs, but their use will expand the economy's capacity to produce goods in the future. A deferral of current consumption is the economic cost of increasing consumption in the future. The calculation that economic agents have made that warrants incurring this cost is that what is given up today is more than compensated for by what is gained tomorrow.

This use of current resources for capital deepening is what the economist defines as investment. High rates of investment lead to faster accumulation of the stock of physical capital, and that ultimately translates into a more rapid expansion of the economy's productive capacity. The necessary economic corollary to investment is saving, diverting a share of current income from current consumption. Therefore, economies with high rates of investment will also tend to have high rates of saving. Because it is possible for a nation to borrow from (use the saving of) other nations, there does not have to be an exact concordance of domestic saving and investment, but over the long run the two do tend to be highly correlated.

The importance of investment for economic growth is suggested by the very strong historical correlation in cross country data between rates of investment (as a share of GDP) and rates of economic growth. For example, over the last 50 years countries such as Japan, Singapore, and South Korea, which have had high saving rates (25% to 35% shares of GDP) have also had high growth rates (5% to 7% annual rates of increase in per-capita GDP). On the other hand, countries such as Rwanda, Bangladesh, and India, with low investment rates (5% to 15% shares of GDP) have also had low growth rates (1% to 1.5% annual rates of increase in per-capita GDP).

The United States' rate of investment averaged about 20% of GDP over this 50 year span and, as already noted, per-capita GDP grew at an average annual rate of nearly 2% per annum. However, in recent years the U.S. investment rate has fallen to about 15% of real GDP. While correlation does not necessarily indicate causation, and the causation could run from growth to investment, most economists would judge that there is a strong positive linkage between investment, capital deepening, and economic growth.

Interestingly, for most of the post-war period, economic analysis of the sources of U.S. economic growth attributed a relatively modest contribution to capital deepening. Estimates at that time indicated that only 10% to 15% of the observed growth rate was the consequence of the accumulation of physical capital.[8] Moreover, in the standard theoretical model used to analyze economic growth, it was not possible to sustain an acceleration of the long-term growth rate through capital deepening alone.[9]

In the standard theory of economic growth, the force that steadily dissipates physical capital's impact on long-term growth is *diminishing returns.* Successive additions to the stock of physical capital yield steadily smaller increases in worker productivity, to the point where there will be little growth-boosting effect remaining. Capital deepening can temporarily boost the rate of productivity and raise the level of income, but it cannot permanently increase the rate at which they grow. This temporary acceleration of growth would most likely stretch out over a period of many years, and it would, of course, leave the economy at a higher level of income than would have otherwise occurred. In early formulations of this standard model of economic growth, however, this temporary boost was not thought to be particularly large.

Similarly, diminishing returns to capital also help explain why many other economies grew much faster than the United States over the last 50 years. Whether recovering from the devastation of World War II (such as Japan and Germany) or just beginning the transition to an industrial economy (such as Korea and Singapore), the undertaking of a process of capital deepening was occurring to a far smaller existing stock of capital than that of the United States. As a result, it was incurring little or no attenuation of productivity growth because of diminishing returns, so that equal-sized rates of investment had a larger impact on worker productivity in these capital-poor countries than they did on the capital-rich economy.[10] Therefore, a slower growing U.S. economy was not necessarily underperforming in relation to these faster growing economies, rather it was just moving at the slower pace consistent with its much larger stock of physical capital.

In the last decade and a half there has been a large increase in research on the question of what propels long-term economic growth. One of the important outcomes of these recent explorations has been a sizeable upgrading of the estimated effect of capital deepening on the long-term growth rate of the U.S. economy. That effect is now judged to be near 50% of the observed growth rate of output.[11] This boost in the estimate of the productive contribution of physical capital reflects two changes in thinking: one, an increase in the estimates of physical capital's relative importance in the productive process, which translates into any given increase in the size of the capital stock causing a larger *initial* impact on output; and two, a slowing down of the rate

[8] Edward Denison, *Accounting for United States Economic Growth 1929-1969.* (Washington: The Brookings Institution, 1974).

[9] Robert Solow, "Technical Change and the Aggregate Production Function," *Review of Economics and Statistics,* August 1957, pp. 70-92.

[10] CRS Report 95-900, *Rapid Growth of the Asian NICs: Economic Menace or Model?,* by Craig K. Elwell. No longer in circulation but available from the author to congressional clients upon request.

[11] See Dale W. Jorgenson and Kevin J. Stiroh, "Raising the Speed Limit: U.S. Economic Growth in the Information Age," *Brookings Papers on Economic Activity,* no. 1 (Washington: 2000) pp. 125-211.

of dissipation of that initial impact by the advance of diminishing returns due to an output-boosting *complementarity effect* from associated increases in human capital (e.g., new skills).[12]

The likely importance of complementarity effects between the individual determinants of economic growth points to the importance of their overall pattern of accumulation. There is likely to be a pattern of joint accumulation that generates the greatest boost to output. Physical capital is not only important in its own right, but new technology will often only be applied to the production process *embodied* in new capital equipment. That new machine, embodying the new technology, will be most efficiently used if workers also have the boost in skills needed for its effective operation. Similarly, some portion of improvements in human capital will occur through a process of *learning by doing* as workers have access to the new physical capital embodying the new technology.[13]

Also, the accumulation of physical capital embodying new technology may induce further advances in technical knowledge not likely to be captured by the initiating investor. This type of external benefit may manifest as a *learning by observing* effect as initial investors incur the costs of figuring out the best organizational patterns for using the new technology and subsequent investors replicate these patterns at much lower cost. For example, "mass production" was initiated and perfected by a few firms, but once the productive benefits of this new process were clearly evident it was quickly adopted by other firms, bringing sizeable economic benefits to the wider economy that were not included in the initiating investors' profit-loss calculation.

At the microeconomic level there is evidence in the case of adoption of new information technology (IT) technology, that a few firms will undertake significant reorganization and make large initial investments in physical capital to take advantage of the new technology. Once they have settled on a form that successfully incorporates that technology in their operation, it will then be replicated in a far less costly undertaking by competitors.

Another manifestation of production complementarity is the *learning by using* effect, whereby the propagation of a new technology embodied in new investment goods generates a burgeoning of derivative technological advances. A good example of this effect occurred with the widespread diffusion of electrical power into American industry, bringing with it an expanding opportunity for learning and experimentation with this new technology, through which further technological advances, such as the small electric motor, were developed.[14] In many economies this correlation has been found to be particularly strong for investment in machinery and equipment.[15]

The probable complementarity of physical capital with human capital and technological knowledge in the production process has possible implications for economic policy. Because a portion the total economic benefits of investment in physical capital are spillovers to other firms that will not be taken into the profit—loss calculation of the potential investor, there is a likelihood that the actions of private investors will, from society's point of view, lead to under-investment in acquired capital.

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[12] N. Gregory Mankiw, David Romer, and David Weil. "A Contribution to the Empirics" of Economic Growth." *Quarterly Journal Economics* 1992, no. 107, pp. 407-438.

[13] Kenneth J. Arrow, "The Economic Importance of Learning by Doing." *Review of Economic Studies,* 1962, 29, pp. 153-173; and Claudia Golden and Lawrence Katz, "The Origins of Technology-Skill Complementarity," *Quarterly Journal of Economics* 113 (3), pp. 693-732.

[14] Warren Devine, "From Shafts to Wires: Historical Perspectives on Electrification." *Explorations in Economic History,* 63 (2), 1983, pp. 347-372.

[15] Bradford J. DeLong and Lawrence H. Summers, "Equipment Investment and Economic Growth," *Quarterly Journal of Economics* 115 (2), 1992, pp. 445-502.

When there is such a divergence between the social and private rate of return from an action, there is a possibility that public policy can be used to affect a better economic outcome than what the private market alone would achieve. (Specific policy responses are discussed in a later section of the report.)

Human Capital

A worker's productivity can also be magnified by increasing the knowledge and skills he brings to the job, or as economists call it, through *increases in the stock of human capital.* In terms of the example used in the previous section, giving a worker a backhoe who previously only had a shovel, will not boost the worker's output until she has also acquired the skills needed to operate the enhanced physical capital. Human capital is most often augmented through education, not only formal education such as grade school, high school, and college, but also on-the-job training, both formal and informal.

As such, human capital investment is analytically distinct from increased technical knowledge. Human capital refers to the various abilities that allow the worker to understand and apply new productive knowledge. Technical knowledge can be likened to the books in the library, and human capital to the ability to read and understand what is in those books. (The invention of calculus added to the stock of technical knowledge, whereas, taking a calculus course adds to the stock of human capital.)

Other than its direct application to the production of goods and services, increases in human capital in the form of researchers, scientists, and engineers will also likely influence the creation of technological knowledge and exert an indirect influence on the growth of worker productivity.

Human capital is the same as physical capital in that it is also produced by diverting resources (students, teachers, schools, and libraries) from the production of goods for current consumption. Therefore, the accumulation of human capital is also a form of investment: a deferral of current gain in anticipation of a greater future gain. Also like physical capital, the accumulation of human capital will be subject to diminishing returns.

The magnitude of human capital investment is most often measured by years of educational attainment. By that standard, the United States over the last 125 years has undertaken substantial investments in human capital. For the entire population the educational attainment for members of the population who had completed their education increased by 6.7 years for cohorts born between 1876 and 1975.[16] The rate of increase in educational attainment was fastest from 1875 through 1951, with a gain of 6.2 years. However, there was a sizeable slowing of this rate of increase over the next 24 years, with a total gain in this recent period of only about 0.4 years.

The 75-year period of rapid increase in educational attainment was broadly reflective of the nation's steadily rising commitment of resources, beginning in the 19th century, to mass education. This occurred first at the elementary grade levels and subsequently at the high school level, leading to better-educated young cohorts replacing less well-educated older cohorts as time passed.

For the purpose of accounting for economic growth, however, the more appropriate measure of human capital growth is the educational attainment of the labor force. Trends in the educational

[16] This discussion of educational attainment the contribution to economic growth follows that found in: J. Bradford DeLong, Claudia Goldin, and Lawrence H. Katz, "Sustaining Economic Growth," in Henry Aaron, ed., *Agenda for the Nation* (Washington: Brookings Institution, 2003). Studies that find similar results are: Dale Jorgenson, "The Quality of the U.S. Work Force, 1948-1995" unpublished paper, Harvard 1999, and Daniel Aaronson and Daniel Sullivan, "Growth in Worker Quality." *Economic Perspectives* 4Q (Chicago: Federal Reserve Bank, 2001).

attainment of the labor force differ from those of the total population because of differences in the size of age cohorts and differences in the labor participation rates by age and sex. However, data on educational attainment of the U.S. labor force are available only from 1940. Those data reveal a rapid gain in the educational attainment of the labor force from 1940 to 1980 followed by a substantial slowing of the rate of increase from 1980 to 2000. Average years of schooling increased 4.4 years—rising from nine years to 13.4 years. In 1940, 70% of the labor force had *less than* a high school education and *less than* 6% had a college degree. In 2000, only 11% had *less than* a high school education and 28% had a college degree. Increases in college education have been an important source of the rise of educational attainment in recent decades. Nevertheless, the two decades since 1980 saw the slowest gains in educational attainment of the labor force of any 20 year interval.

Increases in educational attainment of the average worker for the time period 1915 to 2000 is estimated to have directly contributed, on average, about 0.35 % per year to the rate of growth of per capita real output, or about 20% of the 1.8% trend growth rate of per-capita output.[17] This contribution, however, does not include any estimate of the hard-to-calculate indirect benefits that the growth of educational attainment might have had on the growth of new technology and through that on productivity.

In contrast to physical capital, a large proportion of human capital accumulation in the U.S. economy has been the result of some form of government subsidized schooling. This reflects an explicit or implicit belief that human capital investments would be under supplied by the private market. The chief economic rationale for public provision of education is that capital market imperfections and financial liquidity constraints of lower income families would cause suboptimal investment in many types of human capital.

It can also be also argued that education generates external benefits that are not going to be tallied in the rate-of-return calculation of the private investor, leading to an undervaluation of the rate of return to education, and from society's viewpoint an under investment in human capital. These external benefits could include facilitation of the exchange in ideas, expansion of opportunities for imitation, and learning by doing.

Another potentially important externality associated with human capital investment was discussed in the previous section on physical capital—complementarity in the production process. In this case, it is a result of investments in human capital having positive effects on the investment of physical capital. For example, an entrepreneur may not be willing to make a substantial investment in physical capital unless there is also a sufficiently large pool of skilled labor for the new enterprise to draw upon. Again the implication is that the private market by itself is likely to under invest in education and human capital accumulation.

Despite ongoing large public investments in education could there still be significant degree of market failure that causes the U.S. economy to under invest in human capital? Given the historical importance of education in generating U.S. long-term economic growth, it is reasonable to be concerned that the recent slowing of the growth of educational attainment may undercut the United States' ability to sustain the pace of economic growth in the future. Also, evidence of very high rates of return to specific types of education, and education support programs for subgroups of the population, suggest that it may still be possible to boost the rate of economic growth through further corrective public policy initiatives in these areas of human capital accumulation.

[17] See DeLong, Goldin, and Katz, op. cit., and Jorgenson and Stiroh, op. cit.

Technological Knowledge

In economics, the phrase 'technological knowledge' refers to the way scarce inputs are brought together to produce desired goods and services. Whether the growing of wheat, the manufacture of automobiles, or the development of a new drug, the steady improvement of technology over time, by allowing the production of more and better output from any given endowment of economic resources, is the "engine" that drives long-term growth and sustains improvement in the nation's economic well-being.

In the analytical framework of the most widely accepted models of economic growth, advancing technological knowledge plays the critical role of pushing back the onset of the diminishing returns that would otherwise steadily reduce over time the productivity-raising and growth-sustaining ability of successive additions to the economy's stocks of physical and human capital.

The magnitude of the contribution of advances in technological knowledge to long-term economic growth has recently become a matter of some debate among economists. The issue is not whether a steady improvement in technological knowledge is what ultimately sustains long-term growth, but rather the size of its effect and what factors determine that improvement. The seminal post-war literature on growth generally attributed about 75% of the growth in output per labor hour to technical progress. In these studies technical knowledge and its output impact were not estimated directly, but derived as a residual that remained after the easier-to-measure contributions of physical and human capital to economic growth were estimated. It was recognized that this residual was probably also picking up the contributions to output of other unmeasured forces such as resource re-allocation, economies of scale, and unmeasured capital and labor. Nevertheless, advancing knowledge was still thought to be the most important force generating U.S. economic growth.[18]

Moreover, from the standpoint of economic policy, this model of economic growth indicated that technical progress was determined by extra-economic forces such as the progress of science, demographic patterns, and the existence of cultural attitudes and socio-economic institutions that govern incentives to save and invest. In general, these are determinants of technical progress and long-term growth that are unlikely to be significantly influenced by economic policy.

More recent research has changed this picture somewhat. As already noted above, more recent investigations have led to an increase in the estimated contribution to economic growth attributable to both the accumulation of physical and human capital and, in turn, a commensurate reduction of the estimated size of technological knowledge's contribution. It is still very important, however, as it likely accounts for 40% to 50% of the rate of growth of real GDP per worker hour.

Recent research on economic growth has also taken a closer look at the likely determinants of technical progress, looking to explain this phenomenon as the consequence of purposeful economic behavior, influenced by typical notions of risk and reward, and perhaps open to influence by economic policy. The various versions of these new models are categorized under the heading: *endogeneous growth* theories. This simply means that the advance of technical progress is explained by the theory and not just taken as an unexplained external force.[19] It would be inaccurate to say that endogenous growth theories have supplanted the standard model, but

[18] See Solow, op. cit. and Denison, op. cit.

[19] See Paul Romer, "Endogenous Technical Change." *Journal of Political Economy,* 89 (5), 1990, pp. 71-102; and Charles I. Jones. "R&D—Based Models of Economic Growth." *Journal of Political Economy,* 103 (August, 1995) pp. 759-784.

they have induced a more economically realistic rendering of the very important process of accumulating a stock of technical knowledge.

The recent economic analysis of advancing technological knowledge proceeds very much like the analysis of physical and human capital. At any point in time, the economy possesses a given stock of technological knowledge. By continually adding to that stock it continually expands the productive potential of the economy, that is, generates sustained long-term economic growth. These actions taken to add to the stock of productive knowledge are also a form of investment in that the accumulation only occurs by channeling some of society's scarce productive resources away from the current production of final goods and services. Scientists, engineers, research facilities and equipment are scarce productive resources that could otherwise have been used for the current production of final goods and services, and are the opportunity cost of producing technological advance and sustaining long-term economic growth. It is the prospect of future gain that will exceed these costs that drives the accumulation of technical knowledge in a market economy.

Measuring the stock of technological knowledge is a problematic undertaking, however. A more tractable task is an accounting of the flow of endeavors that most likely lead to additions to that stock. Factors thought indicative of investment in technological knowledge that can be measured include changes in the number and share of scientists and engineers in the labor force, the level and intensity (share) of spending on research and development (R&D), and the rate of issue of new patents. Based on such measures, the United States (and other industrial economies) has demonstrated over the last century a rising commitment of resources to creating technical knowledge, but there is some evidence of a waning of some elements of these efforts in recent years.

The most basic input to the production of knowledge is the number of heads devoted to the task: more thinkers tend to generate more ideas. The number of scientists and engineers engaged in R&D in the United States has increased dramatically. From 1950 to 1990 the number grew from less than 200,000 to nearly 1,000,000, or an increase from about 0.25% of the labor force to nearly 0.75%.

A more comprehensive indicator of the resource commitment to the production of technical knowledge is economy-wide expenditures on R&D. R&D expenditures have also steadily increased, rising from about $25 billion in 1953 to $312 billion in 2004. As a share of GDP, however, R&D expenditures have not shown a sustained upward trend, rising from about 1.4% in 1953 to a peak value of nearly 2.9% in 1964, but since then fluctuating around 2.5% of GDP, standing at 2.7% of GDP in 2004. For comparison, R&D expenditures as a percentage of GDP in the European Union was 1.9%, in Japan it was 3.1%, and it was highest in Isreal at 4.9%. The steadiness of this share indicates that the United States has not increased the intensity of its research efforts in step with the size of the economy. This steadiness also masks a significant change in the source of funding for R&D. Industry share has risen and that of government has fallen. This change likely has implications for the type of research being funded and the social return forthcoming from the investment.[20]

There is an imperfect understanding of the nature of the translation from resource inputs, to knowledge creation, and then output growth, making evaluation of the economic significance of these efforts imprecise and generally qualitative in nature. For example, while economists may be reasonably confident that here is a positive causal relationship running from the level of resource

[20] Data on science related employment and research spending was taken from: *Science and Engineering Indicators—2006,* National Science Foundation.

commitment in R&D to the rate of advance in technical knowledge, the exact character of the transformation is not known.

It is known, however, that the inherent characteristics of knowledge create a substantial bias against market-driven behavior investing enough in its creation. Improving technology is largely a process of generating new ideas. To the extent that new ideas lead to profitable outcomes, and those profits can be secured by a private firm or individual, the market economy will generate new ideas and foster technological change.

An inherent attribute of ideas, however, is that they are *non-rival,* as my using an idea does not preclude someone else from using it. Further, ideas often have the attribute of *limited excludability*, meaning the owner of the idea will find it difficult or impossible to collect a fee from others who benefit from it. These attributes cause a divergence of private benefit and social benefit, meaning what the creator of the idea can expect to gain less than what the overall economy can expect to gain. In this situation (as already observed with investment in physical and human capital) we would expect the rate-of-return calculation that guides the investment in idea production decision of the private investor to undervalue projects' true benefits and bring forth less than the socially desirable level of R&D effort.

Therefore, the creation of technical knowledge is an activity likely subject to a significant degree of market failure. This will usually mean that it is an activity that may warrant some level of government support if it is to be done on a socially optimal scale.

The Infrastructure for Growth

While accumulations of capital and knowledge are the instruments that directly determine the pace of medium-term and long-term economic growth, they are not by themselves sufficient to assure that an economy will be on a path of sustained improvement in economic well-being. That outcome will also likely be the consequence of the existence of an interlaced group of conditions and attributes that form an "*infrastructure for growth*" that enables and encourages the forward-looking acts of accumulation and invention that propel economic growth. This infrastructure is comprised of laws, government policies, socio-economic institutions, and cultural attitudes that are conducive to the entrepreneurial activity that generates sustained long-term economic growth.[21]

Economic history provides examples of the critical role of the growth infrastructure. In the fourteenth century, China stood far ahead of Europe in its inventiveness, accumulation of technical knowledge, and capacity for the accumulation of physical and human capital. Yet by the sixteenth century, it was Western Europe that was set to initiate the "industrial revolution" and China had lapsed into a state of economic stagnation. While there is disagreement about the complete explanation for China's failure to sustain long-term growth, economic historians see a key factor being the emergence in the Ming dynasty, that had come to rule in this period, of a general lack of institutional support for enterprising behavior. The admixture of a large controlling bureaucracy, the absence of political opposition, and the Ming rulers' preference for stability over surprise were likely inimical to economic growth.[22]

A more recent example of the adverse effect of an unsupportive growth infrastructure is the case of Argentina. At the end of the 19th century Argentina had one of the world's highest levels of per-capita income. But by the end of the twentieth century, it had fallen to less than half that of the

[21] For a more extensive discussion of growth supporting infrastructure see Charles I. Jones, *Introduction to Economic Growth*. (New York, Norton & Company: 1998) pp. 127-145.

[22] See Joel Moyker, *The Lever of Riches.* (New York, Oxford University Press: 1990).

United States. Again, the decline is thought to be, in part, the consequence of government policies that discouraged investment and invention, and undermined economic growth.

Examples of the obverse, growth miracles rather than growth disasters, can also be cited. The biggest example of the favorable interaction of capital and knowledge accumulation with the concurrent development of an growth-enabling infrastructure is post-World War II Japan. That country had been an industrializing economy since the 1870s, but its rate of growth of per-capita output had been no better than moderate in this pre-war period, with per capita output never surpassing 25% of the U.S. level. After the war, however, the initiation of significant institutional reforms improved that economy's growth infrastructure and was likely a major reason for the dramatic acceleration in the pace of Japanese economic growth over the next 40 years, far outpacing that of the United States and increasing Japan's per-capita income to nearly 70% of that of the United States. Other east Asian economies such as South Korea, Singapore, and Hong Kong are more recent examples of the positive influence of a well conceived "growth infrastructure" on long-term growth.

An institution seemingly of central importance to economic success in general and achieving sustained economic growth in particular, is the *market.* A system of markets is a social mechanism widely revealed to greatly facilitate making the basic economic decisions all societies face: deciding what to produce (including decisions about investment in physical capital, human capital, and technological knowledge), deciding how to produce it, and deciding how to distribute what is produced.

At root, markets are an information gathering and dissemination system that directs and coordinates the actions of myriad economic decision makers with great efficiency, leading to outcomes that are consistent with maximum economic welfare. The former Soviet Union is a clear example of the economic inefficiency and poor economic performance of a non-market economy. It was certainly able to accumulate capital and generate some measure of economic growth, but in general the outcomes were well short of any reasonable reckoning of a steadily rising living standard for the average citizen. Of course, the poor performance of the Soviet economy was an important reason for the ultimate collapse of the communist regime there.[23]

The discussion above has implied that government is likely to be an institution with a potentially strong influence, good or bad, on the structure and operation of an economy's growth infrastructure, and through that an influence (good or bad) on long-term economic growth. The positive role of government is likely to involve matters of prescription as well as proscription. While there is no single template for success, many economic historians think that when governments create an infrastructure that on balance encourages production and investment, economic growth occurs. On the other hand, if government on balance encourages diversion, economic growth is imperiled. Investors will not invest if there is not reasonable confidence that the returns on that investment will be theirs and not diverted to others by government.

Government as the *maker and enforcer of laws* can militate against the corrosive effects on economic incentives of corruption, bribery, fraud and theft. A function of law of central importance for all economic transactions is the *establishment of property rights and the conditions of their transfer* from one economic agent to another. This is of importance not just for real property, but also intellectual property. As we know, new ideas are the engine of long-term growth, but due to non-excludability the social return will often be greater than the return to the

[23] For a fuller discussion of the role of markets as effective tools for efficient decision making by countless economic agents see Thomas Sowell, *Knowledge and Decisions*,. (New York, 1984).

creator of the idea. Patent laws and copyright laws serve to bring the private return closer to the social return and thus encourage idea creation.

Modern government can also contribute to the growth infrastructure through the pursuit of *macroeconomic stability*. Inflation, by essentially raising the "noise to signal ratio" in price information, degrades the market's ability to efficiently allocate economic resources, including those that determine the pace of economic growth. Recession and depression deflate the incentives for investment and other forward-looking economic activity. While the swings of the business cycle are unlikely to be avoided, macroeconomic policy can modulate its amplitude and minimize its potential negative effects on economic growth.

The problem of the business cycle reminds us that markets do not always function perfectly, that there will be instances of *market failure.* As was discussed above, markets can fail at the microeconomic level. Physical capital, human capital, and technological knowledge can all have varying degrees of the properties of being *non-rival* and of *limited excludability* so that the social benefit of investment in these factors of production may exceed the private benefit (i.e., return to the investor). In this circumstance the market will not accurately price these factors and there will be a tendency for the acts of economic agents in the markets to lead to an under allocation of resources to these endeavors. Therefore an important aspect of government's role in the operation of a *growth infrastructure* would be to forestall or compensate for such market failures.

Of course, the practical task facing government in correcting for market failure is likely formidable because the properties that prevent accurate pricing by the market will also likely mean that government policy makers will find it difficult to accurately target the source of the market failure and accurately gauge the extent of the under allocation. The risk in a large highly interdependent market system is that an inaccurate or poorly calibrated attempt by government policy to correct for market failure in one area may cause more costly distortions in another area.

A government's tasks extend beyond promoting long-term economic growth, of course. But the other things government does are often likely to have some economic repercussion. Taxation, regulation, operation of the legal system, social safety-net programs and national defense all represent some use of resources that otherwise could be directly applied to investment and economic growth. These are actions that may tend to lower economic growth, but also raise overall welfare of citizens. Issues of importance for long-term growth due to such activities are likely to be the magnitude of the diversion and the degree of neutrality of the diversion on economic decision making, particularity the decisions to save and invest.[24]

Natural Resources and the Limits to Growth

Does depletion of supplies of exhaustible natural resources place a limit on economic growth? This has been a recurring critique of the economists' view of a seemingly unlimited upward path for living standards. While it is a possibility, economists see it as an improbable event. Despite strong economic growth for more than a century, most commodity prices (adjusted for inflation) have not risen and many have fallen, suggesting that supplies of most commodities are at least keeping up with demand and preventing any increase in relative scarcity of commodities. Part of the reason for this has been the steady discovery of new reserves of many natural resources. Finding new reserves, however, is likely to be a bounded process that can-not be relied upon to increase the supply of particular natural resources forever.

There have been other important offsets to resource scarcity, however. The form of many of the advances in *technical knowledge* are innovations in machines and methods that eliminate or

[24] See Stilitz, op. cit., Chapter 1, for more discussion of the economic roles of government.

greatly reduce the need in the productive process for commodities that have grown in relative scarcity. Plastic replaced tin in containers, fiber optic cable replaced copper, and more fuel efficient engines replaced gas guzzlers. These are cases where market incentives have likely induced advances in technical knowledge. As the relative scarcity of a natural resource increases and its market price rises so does the economic incentive to find less costly alternatives. A current example is the sharp increase in the use of *hybrid automobiles* in response to rising gas prices. One cannot guarantee that technical knowledge will always be able to forestall running out of commodities, but the record so far has been very good.

Another counter-force to the rising scarcity of exhaustible resources is *economies of scale*. In many instances, productive processes exhibit increasing returns to scale: as output rises there is a less than proportionate increase in the use of inputs. So with economic growth, the resource intensity of output falls, causing a slowing of the drain on commodity supplies. Historically for the United States, economies of scale have contributed around 10% to output growth. Again, what was true in the past need not carry into the future, but the record cannot be ignored either.

Markets can also take into account considerations of future resource needs and allocate resources efficiently between the present and the future. If the owner of a resource anticipates that rising scarcity will push its price much higher in the future, then he could hold those resources for sale at that future date. Thus the use of some of today's supplies of resources gets pushed forward in time. The market is making provision for the future's need for this resource. Of course, looking into the future is a task filled with uncertainty, and it is possible for market failure to occur. It is unclear, however, that government intervention in this case would do a better job of predicting future resource needs.

Policy Implications of Long-Term Economic Growth

Understanding what determines long-term economic growth does not necessarily mean that economic policy should be used to affect it. That faster economic growth is possible does not necessarily mean it is desirable. There is always a strong presumption in the efficacy of the "market" to get things right, including the rate of investment in physical capital, human capital, and technological knowledge. Market failure can occur, however, when goods have attributes that preclude market prices from fully reflecting the economic value of an activity. If a market failure is present, economic policy can, in theory, be used to improve on the market outcome and raise economic welfare.

In thinking about using economic policy to overcome some form of market failure, it is important to recognize there will often be a distinction between a market failure's "economic relevance" and its "policy relevance." Economic analysis may indicate that a significant market failure is occurring and its correction could generate large economic returns. This, however, does not mean that it will be particularly easy or even possible to craft a policy to correct for the market failure without also causing distortions and other inefficiencies that will lead to the policy generating more economic cost than economic benefit. The often incomplete information about the market failure's precise location, extent, and degree of interconnection with other economic activities elevates the risk of the policy creating more inefficiency than efficiency and doing more economic harm than a good.[25]

In the preceding section of the report on the determinants of economic growth, economic theory and evidence established reasons to suspect that, due to various forms and degrees of market

[25] For further discussion of market failure and the public policy response to it see Joseph E. Stigler, *Economics of the Public Sector*, Second Edition (W.W. Norton & Company, NewYork: 1988) pp. 71-89.

failure, the U.S. economy under invests in physical capital, human capital, and technical knowledge. Therefore, the potential likely exists for various forms of economic policy, by correcting or compensating for these market failures, to accelerate the rate of economic growth and boost future living standards. In the cases of physical and human capital, economic analysis indicates that the growth-accelerating effect may be temporary, but it would endure long enough to still lead to a significant permanent increase in the *level* of GDP.

Most economists would agree that the "engine of long-term economic growth," the force that sustains a rising living standard decade after decade, generation after generation, is the production of new ideas, or what this report has subsumed under the term "technical knowledge." There is less agreement over what governs the rate of advance of technical knowledge and how it might be influenced by economic policy. Some would argue that the level of resource commitment to R&D is an important determinant of the long-term growth rate and also an activity where a greater degree of public support is warranted.

On the other hand, the acceleration of economic growth commencing in the last half of the 1990s occurred without any increase in R&D intensity. Also the marked historical stability of the U.S. long-term growth rate of real per capita GDP (at a 1.8% average annual rate) for more than 125 years, despite significant changes in a broad array of economic circumstances and policies over this long time span, suggests to others that the generation of technical knowledge and, in turn, the long-term growth rate may be propelled by deeply embedded social forces that are not likely to be manipulated by economic policy.

Of course, if a boost in R&D activity only leads to a temporary medium-term increase in the pace of economic growth it will still have a beneficial effect on future living standards.

As regards the invariability of the long-term growth rate, it is also true that the United States has never really pursued a well-defined and orchestrated long-term growth policy. The closest approximation was the 1950s and 1960s, when the confluence of high rates of investment in physical capital, human capital, and technical knowledge was also a period when economic growth was significantly above trend. Even here it is hard to isolate specific economic policies that contributed to this higher rate of growth. We do observe in this period, however, a rising government commitment to R&D spending, although a sizable share of this R&D was for defense related programs. It was also a time of increased government support for higher education through the GI Bill and other programs. There were also periodic attempts to use the tax code to encourage business investment in physical capital. It was also a period when maintaining economic stability became a central task of government.

The remainder of this section will examine specific economic policies to boost investment in the three principal direct determinants of economic growth and, in turn, accelerate economic growth.

Policies to Increase Investment in Physical Capital

The first question to be answered in regard to investment in physical capital is whether the market failure to be countered is a problem with the investment goods themselves (i.e., complementarities with other factors in the production process) or with the saving behavior (i.e. a saving rate that is to low) that finances investment. The economically appropriate policy response would likely be different for each.

Raising the Saving Rate

The low saving rate of the U.S. economy has been a matter given considerable scrutiny over the last 25 years. As recently as 1998, the U.S. saving rate was 18.3%, but it had fallen to 13.5% by 2005. Other advanced industrial economies typically have a saving rate in the 20% to 25% range.

The economy's overall saving rate is the confluence of saving undertaken by businesses, households, and government, but only the last two have been the source of the fall of the overall saving rate. The government saving rate in the United States has seen the biggest change in recent years, moving down from 4.4 % in 2000 to -0.6% in 2005. This change is a consequence of the federal government budget swinging from surplus to deficit in this period. The least understood change in saving behavior is the precipitous fall of the household saving rate, down from around 7% of GDP in the 1970s and 1980 to below zero today.[26]

The fall of the household saving rate has been the object of much economic research, but the reasons for the decline remain problematic. No single theory can fully account for the phenomenon, but three have considerable plausibility. First, capital gains on real estate, stocks, and other investments, particularly in the 1990s, have greatly increased household wealth. Economic theory predicts that a rise in wealth can reduce the need to save and increases the tendency to spend. Second, increased government outlays for Medicare and Social Security transfer income from a relatively high saving segment of the population to a relatively low-saving segment. Third, more streamlined credit market vehicles, such as credit cards and home equity loans, have removed constraints on household liquidity and prompted increased spending (and reduced saving).

The fundamental issue, of course, is whether the decline of the saving rate is largely the result of optimizing behavior by households to establish a preferred balance between current and future consumption. If it is the result of optimizing behavior on the part of households, the size and abruptness of the fall of the household saving rate suggests a quite startling reduction in the value placed on future consumption, or with the risk associated with realizing that future consumption. Some doubt that such a change could be the exclusive result of optimizing behavior and further suggest that it is at least as likely to be the consequence of an imprudent rise in *economic impatience* or *myopia* resulting from changes in institutions or social conventions. At present, economists can give no definitive answer to the question of whether the low household saving rate is optimal or suboptimal.

If it is judged to be suboptimal, then the issue becomes: how can economic policy best affect an increase in the U.S. saving rate? The debate about raising the household saving rate has centered on the U.S. system of taxation as it works as a disincentive for saving, or as it could be used to raise the incentives for saving. The concerns have included high tax rates on interest income, the double taxation of dividend income, and the inheritance tax. All are widely cited characteristics of the tax system that are disincentives to save. Incentives for saving are provided by the deferred tax liability offered by IRAs, 401(k), and Keogh plans. Expanding the availability and flexibility of such plans is seen by some as a means for raising household saving. Elaborations on this same theme are proposals to shift the basis of the whole tax system from an assessment against income to an assessment against consumption, thereby exempting all household saving from taxation.

One criticism of such proposals for raising the incentive to save is that they will also lead to a sizeable reduction of the tax burden on higher income households, who tend to save a larger share

[26] A negative saving rate by households indicates that as a group they are dipping in to past saving to finance current expenditures. A negative saving rate by the federal government indicates that it is borrowing from foreign and domestic sources to fiance its excess of expenditures over tax receipts.

of their income, and a sizeable increase in the tax burden on lower income households, who tend to save a smaller share of their income. This result is in conflict with many people's notion of fairness.

Another criticism made by many economists of private saving incentive policies is their doubtful effectiveness at raising total saving. There are doubts about whether there is a significant positive effect on private saving and there are doubts about the ultimate effect on total saving, even if the private saving rate is increased. Doubt about a positive effect on private saving arises first because of the apparent inelasticity of saving to changes in the rate of return (i.e., raising the after-tax rate of return will not induce large increases in saving); and second, because such incentives will have two opposite impacts on saving behavior. A *substitution effect* stemming from the raised rate of return, which tends to increase saving, and an *income effect* stemming from the increased wealth of the household, that tends to reduce the need to save and raises current consumption. Studies indicate these two effects may be very close in size, so that such saving incentive programs may have little net effect on the saving rate.

Doubt about the ultimate effect of private saving incentives on total saving arise because tax breaks for encouraging private saving will, through their effect on the balance of the government budget, reduce public saving (or increase government dis-saving) and leave the prospect of a positive overall effect further in doubt.

The effect of changes in the public saving rate on total saving are far less problematic and may be a more effective route by which economic policy can raise saving and investment. The policy maker can be confident that policies that move the government budget away from budget deficits and toward budget surpluses will raise both public saving and total saving. The change will not be one-for-one due to some induced consumption spending, but it will be positive with an added $1 dollar of public saving typically leading to an increase of $0.50 to $0.80 in total saving.[27]

The question about optimizing behavior that had potential policy relevance in the case of the household saving rate is not an issue in regard to the current low public saving rate. The state of budget balance is the result of a series of policy decisions that reflect numerous social, political, and economic problems and goals whose relative importance can change over time. If higher saving, higher investment, and faster economic growth are seen as a high priority, then most economists would judge one of the surest ways for government to support that goal is to raise the rate of public saving by moving the budget balance from deficit to surplus.

Investment Incentives

Economists have a strong suspicion that physical capital has positive external effects on the efficiency of the productive process due to the effect of complementarity on other factors of production. These extra benefits, however, will unlikely be taken into consideration by the private investor, leading to some degree of under-investment in physical capital. In theory, this market failure could be overcome by government policy with an appropriate investment incentive. In practice, however, correcting this market failure is far from straightforward.

It is true that the structure of the tax system can have an influence on the decision to invest, potentially affecting the rate of accumulation of the stock of physical capital as well as the allocation of resources across different classes of investment. Therefore the argument is made from time to time that the structure of the tax system should be shaped to promote investment in physical capital so as to accelerate the rate of economic growth. Pro-investment policies might

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[27] See William Gale and Peter Orszag, "Budget Deficits, National Saving, and Interest Rates." *Brookings Papers on Economic Activity* 2, 2004.

involve more rapid rates of depreciation, investment tax credits, or altered tax treatment of capital gains or corporate profits. But as already discussed above, the economic issue is not a question of whether such proposals can increase the rate of investment in physical capital, but whether that increase is economically optimal.

The prevailing view among economists is that while the tax system should not unduly discourage investment in physical capital, neither should it be used as a mechanism to directly intervene to promote it. In the absence of a true market failure economists argue that the tax system should be *neutral* in its effect on all forms of economic behavior. In the presence of some form of market failure, the daunting information requirements for implementing an efficient investment tax incentive policy make it likely that such a policy would cause distortions in the pattern of investment in types of physical capital, distortions in the allocation of resources between physical capital and other economic ends, and inefficient rent seeking behavior. The ultimate economic effect would most likely be to decrease overall economic efficiency and reduce economic welfare.[28]

On the other hand, as discussed in regard to saving incentives economic theory and evidence indicates that by running budget deficits (outside of periods of recession) government generates a dis-incentive to private investment spending by diverting a share of the economy's saving away from private investors.[29] There is no economic presumption that this diversion is economically optimal. Therefore, inclining the budget towards surpluses that add to the nation's flow of saving and tend to stimulate investment spending is probably the surest and least distorting way the government can provide incentive for investment in physical capital.

Policies to Increase Investment in Human Capital

The government has long played a large and active role in support of education. It is the dominant supplier of elementary and secondary education and also provides sizable support for higher education. A steady rise in the quality of the labor force has been an important force behind U.S. economic growth over the last century, but a source of concern for sustaining the rate of growth is the decline in the average educational attainment of the labor force evident since 1980. Not reversing this decline is likely to ultimately have a negative effect on the pace of economic growth and the future level of economic well-being.[30]

The economic literature on education policy and human capital accumulation is vast and it is beyond the scope of this report to relay in full. There are a couple of issues, however, that seem to be of particular significance as they seem to offer potentially high rates of return. High rates of return are guides to areas where an increased allocation of resources will improve economic efficiency and raise social well-being. From the standpoint of economic efficiency, the great

[28] For further discussion of the structure and effects of the U. S. tax system see Joseph E. Stiglitz, op. cit. pp. 534-590; CRS Report RL32808, *Overview of the Federal Tax System*, by Jane G. Gravelle and Donald J. Marples; and CRS Report RL31235, *The Economics of the Federal Budget Deficit*, by Brian W. Cashell.

[29] In an economy such as that of the United States, that is open to international trade in assets, inflows of foreign capital can compensate for some of the shortfall of domestic saving, allowing the undertaking of domestic investment at a higher rate than would otherwise occur. But in most circumstances, there will still be some dampening of domestic investment. Moreover, the future returns of that externally financed investment will largely accrue to foreigners and to that extent not effect an increase in domestic living standards.

[30] Policies to increase human capital will often have a dual benefit of improving not only the level of output and income, but by generally having the greatest positive impact on those at the low end of the income distribution, improve its distribution as well.

likelihood of market failure in these areas means they are likely candidates for some enhancement of economic policies to induce an increase in the allocation of resources to these areas.

One prominent corollary to the decrease in average educational attainment of the U.S. labor force since 1980, has been a steady rise in the college wage premium. Economics tells us that such a persistently high rate of return is evidence of an under allocation of resources to an endeavor. In this case, from the standpoint of economic efficiency, too few students are seeking college degrees. The share of high school graduates who attend college has increased over this time period, but there are sizable differences in these enrollment rates across family income levels. This would suggest that financial constraints continue to be a barrier to higher education for low to moderate income youths and that policies that increase opportunities for financial aid for such youths could yield large economic returns.[31]

Another area that current research suggests offers large social and economic returns would be expansion of programs that raise the quality of early childhood education for children from low-income families. Good educational outcomes in general are the result of a cumulative process that begins in the earliest childhood years. Poor results in the earlier stages make subsequent success much less likely.[32] Good ultimate labor market outcomes from educational enrichment programs are also likely to depend on the enhancement of non-cognitive skills (i.e., persistence, self-discipline, reliability, etc.) as well as cognitive skills. There is also evidence that an important constraint on access to quality education and human capital growth by children of low-income families is a lack of housing mobility. How to best enhance early childhood education remains a matter of debate, however.[33]

Policies to Increase Investment in Technical Knowledge

Steadily advancing the economy's stock of technical knowledge is acknowledged by economists to be the element of central importance for achieving long-term economic growth. While the accumulation of physical and human capital are important contributors to this process, it's only in conjunction with advances in technical knowledge that these two factors can forestall the growth-slowing onset of "diminishing returns" that they would otherwise be subject to, and sustain long-term growth.

But from a policy perspective, advancing technical knowledge has been somewhat of an enigma. A sizable share of the literature on economic growth does not deny its importance but tells us that it is a phenomenon propelled by forces largely out of reach of economic policy. On the other hand, many economists argue that improvements in technical knowledge are likely to be the result of purposeful behavior and whether motivated by greed, ambition, curiosity, or altruism that behavior is more likely to occur in an economic environment conducive to invention and innovation. This suggests that considerations of market-determined outcomes relating to risk and reward will influence this behavior.

It is also likely that because of the nature of ideas, private markets by themselves will likely cause a less than optimal commitment of resources to their creation. Therefore, an optimal level of

[31] See OECD, *Education at a Glance 2004.* (Paris, OECD: 2005); and Alan B. Krueger and Mikael Lindahl, "Education for Growth: Why and For Whom," *Journal of Economic Literature* 39 (4), pp. 1101-1136.

[32] See Pedro Carneiro, James Heckman, and Dayanand Manoli, "Human Capital Policy." *NBER Working Paper*, no. 9494, Feb. 2003.

[33] See CRS Report RL31123, *Early Childhood Education: Preschool Participation, Program Efficacy, and Federal Policy Issues*, by Gail McCallion and CRS Report RL32871, *Youth: From Classroom to Workplace?*, by Linda Levine.

investment in new technical knowledge may require action by government to overcome this market failure.

Research by Business

Research and development is the activity thought most closely linked to the development of technical knowledge. Business firms undertake R&D on a substantial scale; nevertheless, they likely do less than is socially optimal. Under investment in R&D is suggested by the estimated high rates of social return relative to private return on a wide spectrum of research projects. Research suggests that the level of investment in R&D undertaken by firms may be only 25% of the economically optimal scale.[34]

Can economic policy entice firms to increase their R&D spending? The *patent system* is one manifestation of government's attempt to encourage inventive behavior by providing "property rights" over new ideas. This is a well developed set of laws in the United States but there are some questions about the patent system's impact on R&D activity and economic welfare. It is clear that the functioning of the patent system involves an economic trade-off. There is an economic gain from patents inducing more R&D by companies, but there is an economic cost to consumers of the patented product because the limited monopoly power conferred to the patent holder will result in the product being priced above what would prevail in a competitive market. The magnitude of this cost to consumers will, of course, increase with the length of time the patent is in force. In theory there will be an optimal term for the patent that just balances the social benefit of inducing invention and innovation with the cost of the temporary monopoly power afforded by the patent. Some economists argue that the current patent system is out of balance, giving too much weight to the rights of the inventor and not enough to the wider society that bears the cost of the limited monopoly and that shorter patent terms are needed.[35]

There is also concern by some economists about how efficient the current structure of the patent system is at inducing invention and innovation. The focus of concern is the patent system being in some situations an impediment to the process of information transfer that drives the accumulation of new knowledge.[36] At one level the patent system aids the process of information transfer. For in order to get a patent an inventor must make a full disclosure of the details of their invention, making the knowledge that is inherent to the invention readily available to all who are interested. Therefore, while imitation is not allowed, others may be encouraged to "invent around" the patent or build upon that knowledge to develop other unique products or ideas. And the possibility of "licensing" can allow use of the new knowledge by others. However, for some types of information important to the process of innovation, the "arm's length" market-oriented exchange that patents encourage are perhaps less efficient than various non-market mechanisms. The problem arises because of the often c*ollective and cumulative* nature of information use in the process of innovation. It is collective in that an innovation will often be the result of information flows between several participants, some of whom might be business rivals. Patents may tend to rigidify and slow these types on information transfers. It is cumulative in nature in that a current innovation will often be an essential input to the development of subsequent "generations" of a technology. Because of this characteristic there is concern that a patent system that strongly

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[34] Charles I. Jones and John C. Williams, "Measuring the Social Return to R&D," T*he Quarterly Journal of Economics*, 63 (4) (Nov. 1998) pp. 1119-1136.

[35] See Michele Boldrin and David Levine, "The Case Against Intellectual Property," *American Economic Review,* May 2002; and Adam B. Jaffe and Josh Lerner, *Innovation and Its Discontents: How the Broken Patent System is Endangering Innovation and Progress and What to Do About It,* (New York: Princeton University Press, 2004).

[36] See Thomas Mandeville, *Understanding Novelty: Information, Technology, and the Patent System*, (Ablex Publishing, 1996).

protects the rights of the first generation innovator can impede the information flow necessary for emergence of the subsequent generations of the innovation.

In general, these information transfer issues suggest that, as well as an optimal term for the patent, there will also be an optimal "breadth" of the patent's coverage. Some are concerned that the current patent system is inclined toward creating an overly wide breadth for patents and is slowing down the process of innovation. In cases where a patented "idea" is judged likely to carry particularly large social benefits, the government may better serve general economic well-being by buying the patent from its creator and allowing a quicker and wider dissemination and use of this valuable new knowledge.[37]

Also, in an increasingly globalized economy where the size of the market needed to assure the profitability of a new endeavor often require foreign as well as domestic sales, the patent systems of other nations become relevant to the domestic business firm's willingness to undertake some research projects. There is the prospect that improvement in the establishment and enforcement of property rights internationally could have a positive effect on domestic R&D activity.

Another policy device that attempts to coax more R&D out of business firms is the *R&D tax credit.*[38] As currently structured, the tax code allows a 20% tax credit on R&D expenditures, with the putative effect of stimulating such expenditures by increasing the after-tax return on research projects. While the evidence indicates that the research tax credit does raise R&D spending by firms, many economists have significant doubts about how well the tax credit does at targeting and inducing R&D projects with large social benefits. It is likely that even with the credit, the investing firm will still be inclined to undertake the research projects that offer the company the greatest return rather than those that would offer the largest social return.

Why not use direct grants by government to firms to undertake R&D projects that offer large social benefits relative to private return? Again, as discussed above in regard to incentives for investment in physical capital, the information requirements for operation of an efficient grant program is likely well beyond what government could hope to muster. The economic risk is that a program of direct grants would, by distorting the pattern of investment and by encouraging rent-seeking behavior, generate more inefficiency than efficiency.

A curious aspect of firm behavior and the production of ideas is that in situations where the initial R&D investments for a new idea are very high, but where once created the marginal cost of replication is very low, firms will not undertake this endeavor unless they can expect to charge prices that exceed marginal cost. Otherwise, insufficient profits would be earned. The first copy of the Windows operating system cost hundreds of millions of dollars, but the cost of producing all subsequent copies (the marginal cost) is near zero. Pricing above marginal cost, however, violates one of the basic conditions for efficient market outcomes and connotes the presence of monopoly power and the attendant loss in consumer welfare. Government anti-trust policy is predicated on preventing such behavior. Yet, in this circumstance anti-trust action would be antagonistic to invention, innovation, and economic growth.

Research by Government

Despite government incentives, large areas of economically beneficial research are unlikely to ever be undertaken by private, profit seeking business firms. Most often this new knowledge will,

[37] For further discussion of the patent system and innovation see CRS Report RL31281, *Patent Quality and Public Policy: Issues for Innovative Firms in Domestic Markets*, by John R. Thomas.

[38] See CRS Report RL31181, *Research and Experimentation Tax Credit: Current Status and Selected Issues for Congress*, by Gary Guenther.

in addition to having large economic benefits, also have the attributes of being both highly *nonrival* and *unexcludable*. Therefore, such research, usually called *basic research,* will only emerge through government funding. Moreover, the beneficial outcomes of basic research are often unanticipated, arguing for casting a wide net of research support rather than a highly focused funding strategy. The fruits of past basic research have included the development of longitude and quantum physics, the discovery of DNA and penicillin, and the invention of the transistor and the laser.

Basic research is currently supported through the budgets of many government agencies including the National Science Foundation, National Institutes of Health, NASA, the Department of Energy's Office of Science, and the Department of Defense. Much of the actual research is done at major universities across the country.[39]

One policy issue for basic research is determining the appropriate level of government funding. The rate of accumulation of technical knowledge is likely to rise with the level of resources devoted to it, but the speculative nature of basic research makes it all but impossible to judge what the economically optimal size of government spending on such research would be. The absolute level of inflation adjusted government spending on basic research increased from about $1.4 billion in 1953 to about $39 billion in 2004. About $21 billion of these funds were allocated to universities and colleges where the research is performed. The intensity of government funded basic research, however, has fallen, decreasing from about 0.7% of GDP in 1953 to about 0.2% of GDP in 2004. International evidence has shown that there is a positive correlation between the intensity of government-funded basic research and economic growth. Nevertheless, the understanding of linkage between basic research and economic growth is not well specified, making it difficult to predict the precise pay-off in economic growth from a given increase in spending on basic research. This, in turn, makes it difficult to say what the optimal level of such spending should be.

A second policy issue with government funded basic research is the mix of that funding across areas of scientific inquiry. The share of government research spending in health related areas has risen steadily for the last 30 years and has increased dramatically over the last 10 years. Funding for life sciences now accounts for 60% of the government's basic research expenditures. In contrast, inflation-adjusted funding for basic research in the physical sciences has not risen over the last 30 years and accounts for only 10% of the government's budget for basic research.[40] Some argue that this disparity in funding is inconsistent with the often interdisciplinary nature of major innovations, and is a movement away from the balanced basic research portfolio that is most likely to yield the maximum long-run return. This argument is not that research funds should be reallocated away from health areas, rather that there should be a more balanced increase across all areas of basic research.

Conclusion

Sustained long-term economic growth is a defining characteristic of the highly successful U.S. economy and, perhaps more significantly, it is also a basic presumption that undergirds American society. Economic well-being is expected to improve for the current and each successive generation. To be able to realistically hold such an expectation is reflective of a momentous

[39] For an overview of current federal programs supporting R&D see CRS Issue Brief IB10088, *Federal Research and Development: Budgeting and Priority-Setting Issues, 109th Congress,* by Genevieve Knezo.

[40] See data in: National Science Foundation, *Science and Engineering Indicators 2005.*

economic achievement. Over the long course of history, sustained economic growth has been a rarity and even today all too many nations struggle to achieve it.

Economic historians suggest that one thing that likely demarcates past failure from current success at achieving sustained growth, as well as the current disparities between rich and poor nations, is the development of an *infrastructure* for growth. This is an amalgam of laws, government policies, and institutions that form an environment that, on balance, encourages production and economic transactions.

Given this supporting infrastructure, economic theory and evidence make it reasonably clear that countries that have achieved sustained long-term growth such as the United States are those that invest a sizable fraction of current income in the accumulation of physical and human capital and have accumulated large stocks of both. More importantly, they are also economies that have been able to steadily raise the productivity of these two inputs through a steady advance of technical knowledge.

There are reasons to believe, despite its evident economic success, that the United States, due to varying degrees of market failure, may under invest in each of the three basic determinants of economic growth. In theory, correcting that under investment through some form of government intervention could lead to an optimal increase in the rate of accumulation of each determinant, and through that an acceleration of the economy's rate of economic growth. In some instances, the induced boost in the rate of growth may not be permanent but the level of future income and output will be higher, nevertheless.

Knowing that there is the potential for improving on certain market outcomes is one thing. Designing economic policies that will efficiently induce these improvements is another thing. The information shortcoming about what, where, and how much to invest that the policymaker would have to contend with will often be substantial, and greatly raise the risk that the policy will be so blunt and misdirected that it generates more economic costs than benefits.

This risk is probably the greatest with policies aimed at increasing private investment and saving. This leads most economists to argue that the surest and most efficient way to raise investment and saving is for the government to run budget surpluses rather than budget deficits. This provides a general incentive to investment in physical capital through its favorable effects on interest rates, but leaves the decision on particular investments with the individual business firm. This may not extract the greatest social benefit, but what is extracted is done with a minimum of the economic cost that would result from the distortions and rent seeking that a more focused investment incentive policy would likely cause.

The government has been a longstanding supporter of human capital accumulation through large scale funding for education programs. These efforts have had a substantial positive effect on economic growth. However, the slipping educational attainment of younger labor force cohorts evident over the last 20 years raises concern about slowing human capital investment leading to a future decrement in the pace of long-term growth. Based on estimates of likely high economic return, policies to improve access to higher education by minorities and members of low income households, and policies to enhance early childhood education may warrant more attention.

New ideas and the accumulation of technical knowledge is what ultimately propels long-term economic growth. The production of new ideas is a process that is unlikely to occur on an economically optimal scale without government support. R&D activities do receive public support, but there is still concern about whether this support is accurately targeted and undertaken on an optimal scale. Of particular concern for public policy is spending on the basic research that is likely an important well-spring for new ideas. Such research is largely dependent on public funding and by some measures, that funding has been steadily waning, and tends to be very skewed in its distribution across research disciplines. This would seem to be a movement away from policies that have a high probability of helping to sustain or accelerate economic growth.[41]

In trying to boost the long-term rate of economic growth, the policy maker faces what is often a thankless task in that he is asking citizens to incur costs today for gains that will only fully accrue decades into the future. In addition, given the maturity and existing strength of the U.S. economy, as well as the revealed historical steadiness of the economy's rate of long-term growth, it may be that economic policies aimed at an acceleration of the economy's long-term growth rate will boost that rate by only several tenths of a percentage point. Nevertheless, that would be a significant achievement and, as discussed earlier, those seemingly moderate increases cumulate to a substantial improvement in the level of national income 25 to 30 years from now. The bulk of the benefits could be seen as largely a gift from one generation to the next generation.

Finally, policies that encourage one growth determinant at the expense of other determinants are unlikely to accelerate the rate of economic growth. For example, a reduction of the budget deficit that occurs through reductions of government spending that supports investment in education and R&D is not a pro-growth policy mixture. Moreover, the likely interdependencies of the determinants of economic growth suggests that a successful overall growth policy is most likely to occur by generating a balanced advance of investment in each determinant of economic growth so as to gain the fullest benefit from their complementary influence on each other.

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Disclaimer

[41] It bears repeating that support for basic research alone does not produce new knowledge. It must interact with an educated and well-prepared mind and be sustained by an infrastructure encouraging free inquiry.